Current Logistics Research

## AFMC Plans and Programs Logistics Analysis

**Richard A. Moore**

*There is nothing permanent except change.*

**— Heraclitus**

If you are an Air Force logistician, you know change is part of the business. Operational scenarios change, logistics policies change, and information systems change. The list of changes is endless. The challenge logisticians face is managing the risks associated with changes. If we know tomorrow's world will be different from today's, how do we posture the Air Force logistics process to provide world-class support to the warfighter?

That is the question that drives much of the work of the Air Force Materiel Command (AFMC) Management Sciences Division. We are operations research analysts who use our formal training in applying mathematics and modeling to add clarity to decision-making processes in an ever-changing world. As part of the AFMC Directorate of Plans and Programs, we do more than just logistics analysis.

Following is a summary of three of our significant 2004 spares management studies and a list of other contributions made to help Air Force logisticians deal with change. You can request a printed or electronic copy of our 2004 annual report from Samantha Hetrick (937-257-3887 or samantha.hetrick@wpafb.af.mil).

### COLT Implementation at the Base Level—Cost Neutral Readiness Improvements

Which spare parts should the Air Force supply system stock to meet demands from maintenance? If we knew exactly which parts were going to be demanded and when and if we knew how long it takes to receive the parts from suppliers, this would be a trivial problem. But with the uncertainties of the real world, none of this information is known with 100-percent confidence, so it is advisable to use optimization algorithms that determine which parts to stock to minimize back orders based on the variability of these processes. This is what Customer-Oriented Leveling Technique (COLT) does for parts supplied by the Defense Logistics Agency (DLA). COLT is an inventory-level computation system we developed and enhanced over the last 3 years. After the tremendous successes from implementing the program at the air logistics centers (ALC), we worked with Headquarters Air Force Installations and Logistics and the Air Force Logistics Management Agency to export this capability to bases.

Air Combat Command (ACC) nominated Seymour Johnson AFB, South Carolina, to begin a pilot in October 2003, and Air Mobility Command (AMC) nominated Travis AFB, California, to begin a pilot in November 2003. We worked closely with ACC and AMC in 2004 to conduct and monitor the results from the pilots, while improving the COLT model as we learned more about the base environment. The results we saw at the two bases mirrored the success we saw at the depots (Figures 1 and 2).

MICAP hours decreased by 62 percent at these bases 10 to 11 months before using COLT to 11 to 12 months after COLT started. We are confident that these results are attributed mostly to COLT because neither base saw similar performance improvements in non-COLT parts and similar bases did not see the same performance improvement for the COLT parts. It also should be noted that these improvements came about with no increase in spares cost.

As a result of these successes, we will be exporting COLT to other bases in 2005:

- ACC: Ellsworth AFB, South Dakota, and Nellis AFB, Nevada
- Air Force Reserve Command: Homestead ARS, Florida, and Minneapolis-St Paul ARF, Minnesota
- Air Force Space Command: Peterson AFB, Colorado
- Air National Guard: Selfridge ANGB, Michigan
- Pacific Air Forces: Elmendorf AFB, Alaska; Kadena AB, Japan; and Kunsan AB, South Korea
- United States Air Forces in Europe: Keflevik, Iceland, and Spangdahlem AB, Germany

Because of our work on COLT and other efforts aimed at improving spares support to the warfighter, we were recognized, along with Headquarters Air Force Materiel Command (AFMC) Logistics, in receiving the Supply Chain Council Award for Supply Chain Operational Excellence in the Department of Defense category.

### Alternative Forecasting Techniques for Low-Demand C-5 Items—Can Longer Demand History Improve Forecast Accuracy?

In an earlier article, we highlighted how to optimize stock to deal with the uncertainty in forecasting demand. But are there better methods for forecasting demands so that stock levels can be optimized further? Demand forecasting is always difficult, but it is even more troublesome for parts that break very infrequently. In 2001, a C-5 Tiger Team was established to identify policies that could improve logistics support to the C-5 weapon system. The team hypothesized that using forecasting techniques, which apply more than 2 years of historical usage data might produce improved forecasts for parts that fail less frequently than once in 2 years. Based on this initial recommendation, we were asked to review the impact of the following proposed policy: continue to compute rates and factors in the Secondary Items Requirements System (D200A) using 2 years of data unless there had been no usage in the last 2 years; if there was no usage in the last 2 years, then use up to 6 years of usage history to compute rates and factors.

We evaluated the forecast accuracy from the current forecasting technique, which is an eight-quarter moving average, and various alternative forecasting techniques with the 6 years of data:

- Exponential smoothing with four different smoothing parameters (0.5, 0.3, 0.2, 0.1)
- Twenty-four-quarter moving average

The results indicate that the current approach is as accurate as any of the others, and it is much less volatile. But this does not measure the impact on the warfighter. So we extended the analysis to determine the practical benefits of implementing the new technique in D200A and weigh those against the cost of implementing the required system changes in D200A. To accomplish this, we examined the impact of using the new technique on the spare-part stock levels computed by the aircraft availability model (AAM) in D200A. We also analyzed the correlation between the list of affected parts and the list of parts that have caused C-5 MICAPs since January 1999 to determine if the parts with infrequent demand have truly been *problem parts*.

This analysis showed the new forecasting technique would cause AAM to compute a stock level of at least one for each of the affected parts, whereas using an eight-quarter moving average, the current approach, would cause AAM to compute a stock level of zero. Although on the surface it seems as though these increased stock levels would improve the aircraft availability of the C-5 weapon system, further analysis indicates the actual benefit would be somewhat limited. This is caused by most of the affected parts already having serviceable assets on hand. As a result, increasing the stock level would have little to no impact on actual performance. Furthermore, we found relatively little correlation between the affected parts with infrequent demands and the list of parts that have caused a MICAP on the C-5 since January 1999. Specifically, only 38 of the 208 affected parts have caused a MICAP during the period examined. Of these 38 parts, the performance of only 5 could be improved through an increased level because they had no assets on hand (serviceable or unserviceable).

As a result of this analysis, we recommended that, although the performance of this small handful of parts could be improved by implementing the new forecasting technique, it would be more cost effective and would accomplish the same result to categorize these parts as numerical stockage objective (NSO) items within the current requirements computation system. The business rules prescribed in this study can be applied to identify the NSO candidates.

### Impact of Using Realistic Shop Flow Times in the Computation of Spare Part Requirements

A key input to the D200A process for computing spares requirements for the Air Force is the amount of time it takes the depots to repair a part. If it takes longer to repair a part, more spares are required to buffer the warfighter from delays. The computation process historically has used *standard* flow days, which are engineering estimates for how long it should take to repair parts if all repair resources were immediately available in the repair shops. An integrated product team, consisting of members from the Ogden ALC and AFMC Management Sciences Division completed a study showing large differences between standard depot repair times and actual shop flow times obtained from the Inventory Tracking System (ITS). We then analyzed the impact on budget and performance when actual depot shop flow times are used.

We evaluated three scenarios in the analysis:

- A *base line* scenario, using standard shop flow times to compute spares requirements to weapon system *specific aircraft availability targets.*
- *A limited funding* scenario, using the dollars computed in the base-line run. The objective is to compute the aircraft availability from spending the same amount of money as in the base-line run but change the mix of parts by using actual shop flow times in the spares computation.

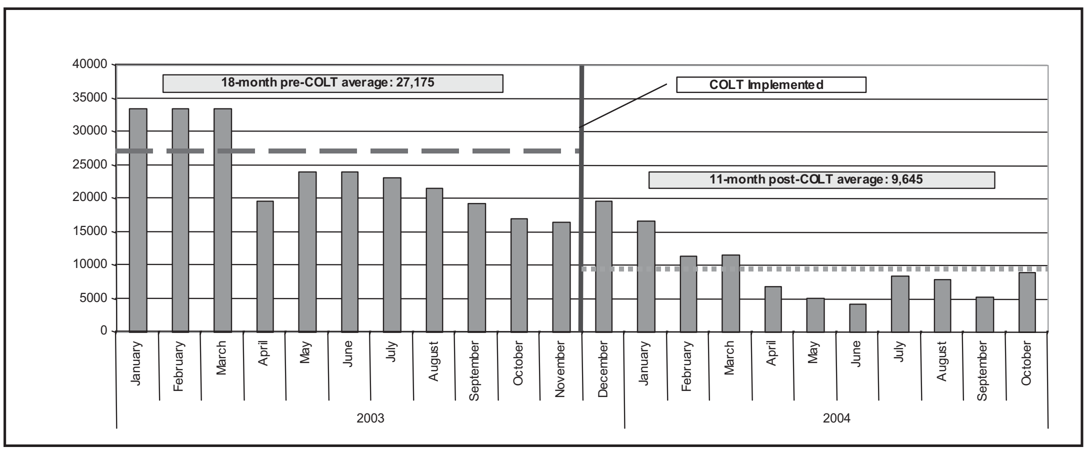


**Figure 1. COLT Item MICAP Hours at Seymour Johnson AFB**

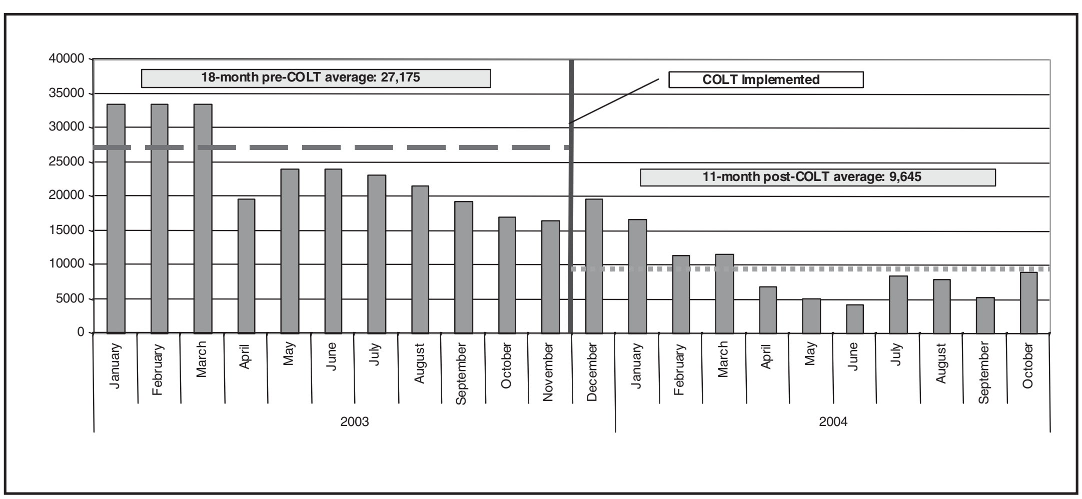


**Figure 2. COLT Implementation at Travis AFB**

- A *full funding* scenario using the actual shop flow times to compute spares requirements to weapon system specific aircraft availability targets.

The difference in availability between the limited funding and base-line scenarios is the expected no-cost performance improvement. The analysis showed that an 18-percent increase in aircraft availability can be achieved—at the same cost—by using actual shop flow times. The full funding scenario also showed that it would cost approximately $450M to fund the spares requirement fully with the actual shop flow times. We briefed this analysis to Headquarters AFMC Logistics who approved implementation of actual shop flow times in the March 2004 D200A computation.

Later, we assisted Headquarters AFMC Logistics with implementation of actual shop flow times in the March and September D200A computations. We obtained 2 years of ITS transactions from each air logistics center to calculate average shop flow times and filtered outliers as appropriate. We then provided these shop flow time values to the AFMC Spares Requirement Branch to be applied in the D200A computation.

### Other Contributions

We helped improve how Air Force logisticians manage uncertainty in a number of additional ways in 2004. Following is a brief summary of our most significant efforts, grouped into four functional areas:

- Performance Measurement
  - Showed that actual performance of reparable spares at the air logistics centers is much worse than planned performance because of understating cycle times for spares during planning processes.
  - Discovered that Air Force demand prediction processes significantly overpredicted and underpredicted spares requirements to support Operation Iraqi Freedom.
  - Built a prototype feedback process to evaluate the prediction of wartime demands.
  - Showed that transferring materiel distribution responsibilities to the Defense Logistics Agency would increase the Air Force spares budget by $30M for each additional day of delay in shipping times.
  - Created a prototype tool to compute supply chain metrics objectively.
  - Identified F-15 subsystems with the highest failure rates to help reduce functional check flight failures during programmed depot maintenance.
  - Provided quantitative results indicating cannibalizations and other workarounds are essential to achieving required warfighter support when the supply chain is constrained by shortfalls in funding or performance.
- Logistics Planning
  - As part of a source selection team, produced various documents and data to be used in the acquisition of an advanced planning and scheduling system.
  - Participated in activities of the strategic planning and balanced score card teams as a full-time member of the Purchasing and Supply Chain Management Integrated Product Team.
  - Began an analysis to determine optimal DLA and Air Force stockage policies.
  - Computed updated spares performance targets that were implemented in D200A.
  - Provided a methodology for determining the economic benefits from improving spare part reliability, which ultimately led to the successful justification for engineering funding.
  - Assisted with the integration of legacy readiness-based math models into the Advanced Planning System demonstration at Oklahoma City ALC.
  - Identified the impacts on sustainment costs of potential force structure changes.
  - Began an investigation into how to better predict the variability in demands for spare parts.
  - Continued building a long-term, archival database of inputs and processing results of both the Air Force and DLA Weapon System Support Programs (WSSP).
  - Provided tools and analysis support for the implementation and ongoing operation of the Air Force WSSP workbench module.
  - Conducted 30 separate studies to address data and process issues associated with the Air Force WSSP.
- Allocating Logistics Resources
  - Continued supporting the implementation of COLT at the air logistics centers, which has resulted in a 56-percent reduction in customer wait time.
  - Used COLT to execute $128M in end-of-year funding at the depots.
  - Completed test and evaluation of the revised aircraft sustainability model that the Air Force uses to compute readiness spares package (RSP) stock levels for aircraft components needed in war.
  - Assisted at the June 2004 RSP workshop, helping to train Air Force personnel who establish inventory levels and manage readiness spares packages.
  - Participated in meetings with wartime supply chain modeling experts to focus on potential improvements to RSP models for capability assessment and requirements computation.
  - Conducted analysis and recommended that the Air Force revisit the decision to implement the inventory efficiency pilot at Oklahoma City and Ogden ALCs.
  - Provided quarterly analysis reports to Headquarters AFMC Logistics senior management to use in approving the implementation of the readiness-based leveling stock levels.
- Executing Logistics Processes
  - Prioritized depot maintenance repair shops according to their impact on the warfighter, which led to a base-line deployment plan for implementing lean manufacturing principles at the depots.
  - Provided analyses to the Air Force Supply Wartime Policy Working Group that showed the Execution and Prioritization of Repair Support System prioritizes RSP requirements equitably with other spares requirements.
  - Validated logic in Recoverable Assembly Management Process for identifying broken parts to evacuate from bases.
  - Began an analysis effort using simulation to reengineer the technical order process.

*Mr Moore is Chief, Management Sciences Division, Headquarters Air Force Materiel Command, Wright-Patterson AFB, Ohio.*